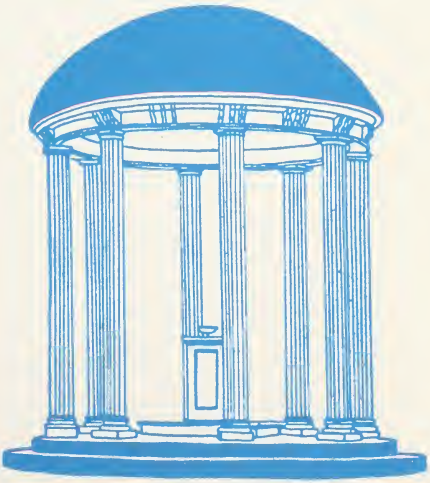
RECORD OF THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

December 1, 1970 *Number 755 Extra*

Department of Statistics



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THE UNIVERSITY OF NORTH CAROLINA

(Six Component Institutions)

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By the act of the General Assembly of 1931 the University of North Carolina at Chapel Hill, the North Carolina College for Women at Greensboro, and the North Carolina State College of Agriculture and Engineering at Raleigh were merged into The University of North Carolina.

By the act of the General Assembly of 1963 effective July 1, 1963, The University of North Carolina comprised: The University of North Carolina at Chapel Hill, The University of North Carolina at Greensboro and North Carolina State of The University of North Carolina at Raleigh.

By the act of the General Assembly of 1965 effective July 1, 1965, The University of North Carolina comprised: The University of North Carolina at Chapel Hill, The University of North Carolina at Greensboro, The University of North Carolina at Charlotte, and North Carolina State University at Raleigh.

By the act of the General Assembly of 1969 effective July 1, 1969, The University of North Carolina comprises: The University of North Carolina at Chapel Hill, The University of North Carolina at Asheville, The University of North Carolina at Charlotte, The University of North Carolina at Greensboro, The University of North Carolina at Wilmington, and North Carolina State University at Raleigh.

Each institution has its own faculty and student body, and each is headed by a chancellor as its chief administrative officer. Unified general policy and appropriate allocation of function are effected by a single Board of Trustees and by the President with other administrative officers of The University. The general administration offices are located in Chapel Hill.

Members of the Board of Trustees are elected by the Legislature, and the Governor of North Carolina is chairman ex officio.

The chancellors of the component institutions are responsible to the President as the principal executive officer of the University of North Carolina.

RECORD OF
THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

December 1, 1970 Number 755 Extra

DEPARTMENT OF
STATISTICS

The University of North Carolina
at Chapel Hill

Announcements for 1970-1971 and 1971-1972

UNIVERSITY CALENDAR

1971-1972

Summer Session, 1971

First Term

June 7, Monday	Registration.
June 8, Tuesday	First day of classes.
June 12, Saturday	Regular classes in all departments.
June 26, Saturday	Regular classes in all departments.
July 9, Friday	Last day of classes.
July 12-13, Monday-Tuesday	Final Examinations.

Second Term

July 15, Thursday	Registration.
July 16, Friday	First day of classes.
July 17, Saturday	Regular classes in all departments.
August 18, Wednesday	Last day of classes.
August 19, Thursday	Reading Day.
August 20-21, Friday-Saturday	Final Examinations.

Fall Semester, 1971

September 14, Tuesday	Fall Semester opens.
September 14-15, Tuesday-Wednesday	Orientation.
September 16-17, Thursday-Friday	Freshman and Transfer registration.
September 20, Monday	Graduate and Upper-classmen registration; Drop-Add for preregistered students.
September 21, Tuesday	First day of classes.
November 24, Wednesday 8:00 A.M.	Thanksgiving vacation begins.
November 29, Monday 8:00 A.M.	Instruction resumed.
December 17, Friday 6:00 P.M.	Christmas recess begins.

January 3, Monday 8:00 A.M.	Instruction resumed.
January 14, Friday	Last day of classes.
January 15-17, Saturday-Monday	Reading Days.
January 18-27, Tuesday-Thursday	Final Examinations.

Spring Semester, 1972

January 31, Monday	Spring Semester opens.
January 31, Monday	Registration.
February 1, Tuesday	First day of classes.
March 25, Saturday 8:00 A.M.	Spring vacation begins.
April 5, Wednesday 8:00 A.M.	Instruction resumed.
May 19, Friday	Last day of classes.
May 20-22, Saturday-Monday	Reading Days.
May 23-June 1, Tuesday-Thursday	Final Examinations.
June 5, Monday	Commencement.

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INTRODUCTION

This brochure briefly describes the graduate programs offered by the Department of Statistics of the University of North Carolina at Chapel Hill.

The material in this brochure is a supplement to that found in the Graduate School Catalog of the University; some of the regulations of the Graduate School have been omitted here. Requests for a Graduate School Catalog should be sent to the Graduate School, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27514.

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

Joseph Carlyle Sitterson, Ph.D., *Chancellor*

Claiborne Stribling Jones, Ph.D., *Assistant to the Chancellor*

Cornelius Oliver Cathey, Ph.D., *Dean of Student Affairs*

Joseph Colin Eagles, Jr., J.D., *Vice Chancellor, Business and Finance*

James Reuben Gaskin, Ph.D., *Registrar and Director of Institutional Research*

Lyle Vincent Jones, Ph.D., *Dean of the Graduate School and Vice Chancellor*

C. Arden Miller, M.D., *Vice Chancellor, Health Sciences*

John Charles Morrow III, Ph.D., *Provost*

Charles Milton Shaffer, B.S. Comm., *Director of Developmental Affairs*

STATISTICS FACULTY BIOGRAPHIES

George E. Nicholson, Jr., *Professor and Chairman of the Department.* A.B. (1940), M.A. (1941), Ph.D. (1948), University of North Carolina. Fellow, Institute of Mathematical Statistics, American Statistical Association, American Association for the Advancement of Science. Member of Council, Operations Research Society of America. Secretary, Institute of Mathematical Statistics (1954-1967).

Major Area of Interest: Operations Research.

Harold Hotelling, *Kenan Professor Emeritus.* A.B. (1919), M.Sc. (1921), University of Washington; Ph.D. (1924), Princeton University; LL.D. (Hon., 1955), University of Chicago; D.Sc. (Hon., 1963), University of Rochester. Fellow, Econometric Society, Royal Statistical Society, Institute of Mathematical Statistics, Royal Economic Society. Member, National Academy of Sciences (1970).

[1]Raj Chandra Bose, *Kenan Professor.* B.A. (Hons., 1922), Punjab University; M.A. (1924), Delhi University; M.A. (1927), D.Litt. (1947), Calcutta University. Fellow, Institute of Mathematical Statistics, National Institute of Science (India); Honorary Fellow, Royal Statistical Society. Member of Editorial Board, Journal of Combinatorial Theory.

Major Areas of Interest: Combinatorial Problems in Experimental Design, Coding Theory, Graph Theory.

1. Retires August 31, 1971.

[2]Indra Mohan Chakravarti, *Professor.* B.Sc. (1948), M.Sc. (1950), D.Phil. (1958), University of Calcutta.

Major Areas of Interest: Design of Experiments, Combinatorics, Information and Coding Theory.

Wassily Hoeffding, *Professor.* Ph.D. (1940), University of Berlin. President, Institute of Mathematical Statistics (1968-69). Fellow, Institute of Mathematical Statistics, American Statistical Association.

Major Area of Interest: Statistical Inference.

Norman Lloyd Johnson, *Professor.* B.Sc. (Math., 1936), B.Sc. (Stat., 1937), M.Sc. (1938), Ph.D. (1948), D.Sc. (1963), University College, London. Fellow, Royal Statistical Society, Institute of Mathematical Statistics, Institute of Actuaries, American Statistical Association. Queries Editor, Technometrics.

Major Areas of Interest: Multivariate Analysis, Experimental Designs.

Malcolm Ross Leadbetter, *Professor.* B.Sc. (1953), M.Sc. (1955), University of Otago (New Zealand); B.A. (1958), M.A. (1962) University of Cambridge; Ph.D. (1963), University of North Carolina.

Major Areas of Interest: Probability, Stochastic Processes.

Walter Laws Smith, *Professor.* B.A. (1947), M.A. (1951), Ph.D. (1953), University of Cambridge. Fellow, Cambridge Philosophical Society, Royal Statistical Society, Institute of Mathematical Statistics, American Statistical Association, Member of International Statistical Institute.

Major Areas of Interest: Probability, Stochastic Processes.

Charles R. Baker, *Associate Professor.* B.S. (1957), University of Southwestern Louisiana; M.S. (1963), Ph.D. (1967), University of California at Los Angeles.

Major Area of Interest: Statistical Communication Theory.

Floyd Jerome Gould, *Associate Professor.* B.S. (1958), University of Chicago; M.S. (1962), Illinois Institute of Technology; Ph.D. (1967), University of Chicago.

Major Areas of Interest: Operations Research, Management Science.

William S. Cleveland, *Assistant Professor.* A.B. (1965), Princeton University; M.S. (1967), Ph.D. (1969), Yale University.

Major Areas of Interest: Time Series, Data Analysis, Bayesian Statistics.

2. Absent on leave, 1970-1971.

THOMAS A. DOWLING, *Assistant Professor.* B.S. (1962), Creighton University; Ph.D. (1967), University of North Carolina.

Major Area of Interest: Combinatorics.

DOUGLAS G. KELLY, *Assistant Professor.* A.B. (1961), Princeton University; A.M. (1967), Ph.D. (1967), Indiana University.

Major Areas of Interest: Probability, Combinatorics, Real Analysis.

RICHARD H. SHACHTMAN, *Assistant Professor.* B.S. (1963), N. C. State University; M.A. (1967), Ph.D. (1968), University of Maryland.

Major Areas of Interest: Probability, Stochastic Processes, and Operations Research.

GORDON D. SIMONS, *Assistant Professor.* B.A. (1960), M.A. (1964), Ph.D. (1966), University of Minnesota.

Major Areas of Interest: Sequential Analysis, Statistical Inference.

WOOLLCOTT K. SMITH, *Assistant Professor.* B.S. (1962), M.S. (1964), Michigan State University; Ph.D. (1969), The Johns Hopkins University.

Major Areas of Interest: Stochastic Processes, Applications to Biological Models.

EDWARD J. WEGMAN, *Assistant Professor.* B.S. (1965), St. Louis University; M.S. (1967), Ph.D. (1968), University of Iowa.

Major Area of Interest: Applied Probability.

STAMATIS CAMBANIS, *Research Assistant Professor.* B.S. (1966), National Technical University (Athens, Greece); M.A. (1968), Ph.D. (1969), Princeton University.

Major Area of Interest: Statistical Communication Theory.

BALRAM S. RAJPUT, *Research Assistant Professor.* B.S. (1958), D.A.V. College, Dehra Dun, India; M.S. (1960), Agra University (India); Ph.D. (1969), University of Illinois.

Major Areas of Interest: Information Theory, Functional Analysis.

KEMPTON J. C. SMITH, *Research Assistant Professor.* B.S. (1964), Carleton University; Ph.D. (1968), University of North Carolina.

Major Areas of Interest: Combinatorics, Coding Theory.

BREWSTER HUNTINGTON GERE, *Visiting Professor.* B.A. (1930), Yale University; M.A. (1934), Syracuse University; Ph.D. (1938), Massachusetts Institute of Technology.

Major Areas of Interest: Analysis, Applied Mathematics.

HISAO WATANABE, *Visiting Professor.* B.S. (1951), Tokyo University; Ph.D. (1965), Kyushu University.

Major Area of Interest: Stochastic Processes.

Javad Behboodian, *Research Associate Professor.* B.S. (1954), Tehran University; M.S. (1961), Ph.D. (1964), University of Michigan.

Major Area of Interest: Mixtures of Distributions.

Donald L. Bentley, *Visiting Associate Professor.* B.S. (1957), M.S. (1958), Ph.D. (1961), Stanford University.

Major Area of Interest: Mathematics-Statistics with Biological Applications.

Nicholas Karl Krier, *Visiting Assistant Professor.* B.S. (1964), Ph.D. (1969), The Ohio State University.

Major Area of Interest: Combinatorial Mathematics.

Georg Lindgren, *Visiting Assistant Professor.* Fil kand (1961), Fil lic (1969), University of Lund (Sweden).

Major Area of Interest: Stochastic Processes.

Clifford R. Qualls, *Visiting Assistant Professor.* B.A. (1961), Long Beach State College; M.A. (1964), Ph.D. (1967), University of California at Riverside.

Major Area of Interest: Stationary Processes.

THE UNIVERSITY AND CHAPEL HILL

The University of North Carolina at Chapel Hill is the oldest state supported university in the United States, first opening its doors in 1795. It is part of the Consolidated University of North Carolina, which has campuses at Asheville, Chapel Hill, Charlotte, Greensboro, Raleigh, and Wilmington. Chapel Hill—a town of about 25,000—blends a mild climate, a relaxed southern atmosphere, pine-covered hills and the charm of a college town with such cultural advantages as an excellent theater, a symphony orchestra, a planetarium, and an art museum. Most of the larger cities in North Carolina are nearby; the Carolina beaches, the Cape Hatteras National Seashore, the Great Smoky Mountains National Park and the Blue Ridge Mountains are but a few hours drive away. Basketball, football, year-round golf, swimming and other athletic attractions are always in abundance in Chapel Hill.

The University, which now has about 18,000 students, is one of the South's leading academic institutions and prides itself on being among the front rank of American universities. Students come to Chapel Hill from all over the world. Within the University, several departments, including the Department of Statistics, have received international recognition.

Students of all races are equally welcome in the University of North Carolina. Persons of all racial backgrounds may apply for and accept admission, confident that the policy and regular practice of the institution will protect them from discrimination.

The Old Well

THE DEPARTMENT OF STATISTICS

The Department of Statistics is a part of the Graduate School of the University of North Carolina at Chapel Hill. It is primarily concerned with graduate teaching and research in the mathematical theory of statistics and probability, and in related areas such as applied probability, communication theory, combinatorics and operations research. In addition to the M.S. and Ph.D. programs, the Department offers an undergraduate major in statistics and courses suitable for graduate and undergraduate students majoring in other areas. The Department works cooperatively with other organizations in providing statistical services for the University through the Institute of Statistics.

The Department of Statistics, through its emphasis on graduate training and research in the mathematical theory of statistics, has, since its organization in 1946, attained the stature of being one of the world's foremost centers of statistical research. Since 1948, over 100 Ph.D. degrees in Statistics have been awarded. Holders of these degrees have assumed positions of responsibility in many important statistical organizations, including the Executive Secretary and Program Secretary of the Institute of Mathematical Statistics, the Editor of the Annals of Mathematical Statistics, and the chairmen of the Departments of Statistics at several American universities. In addition, many professors at leading universities in the United States and abroad and senior statisticians in government and industry received their doctoral training in the Department of Statistics at the University of North Carolina.

Much fundamental work in experimental design, nonparametric inference, sequential analysis, renewal theory, coding theory, estimation, and hypothesis testing has originated here. The Institute of Statistics Mimeograph Series, which now includes over 700 titles, contains the first results of many of the fundamental lines of research in the subject of mathematical statistics as it exists today.

In 1968, the Department of Statistics was the recipient of a National Science Foundation Center of Excellence grant, the purpose of which is to broaden the research base of the department in important theoretical and applied areas, particularly combinatorics, communication theory and applied probability, to complement the already strong work in classical mathematical statistics; and to increase the ability of the department to train more graduate students in an enriched program by providing for five new permanent faculty appointments.

An attractive feature of the Department is its close connection with various other centers of statistical activity at the Consolidated University. The Department of Experimental Statistics, on the Raleigh campus, and the Department of Biostatistics, at Chapel Hill, both

offer a wide range of courses in applied statistics which may be continued with the more theoretically-oriented courses in the Department of Statistics to suit individual needs and interests. The Departments of Mathematics, Computer and Information Science, City and Regional Planning, Economics, and the Psychometric Laboratory, among others, provide opportunities for further training in areas related to statistics.

Through the Institute of Statistics, which is organized to coordinate the various programs in statistics at the University, interdisciplinary programs in econometrics, operations research, biomathematics, population studies, and multivariate analysis have been initiated at the Chapel Hill and Raleigh campuses; these programs promote training and research in their respective areas and are of particular interest to students of statistics.

The Department is located in two adjacent air-conditioned buildings. Most of the faculty and secretarial offices are in Phillips Hall, while classrooms, seminar rooms, research faculty and research assistant offices, as well as a comfortable lounge, are located in the newly-renovated Smith Building.

The Morehead Planetarium

The Mathematics-Physics-Statistics-Information Science Library in Phillips Hall maintains an extensive collection of books and journals pertaining to statistics. Graduate students have unlimited access to this library 24 hours a day. Additional materials in the main University Library are also available.

The University Computation Center is located in the basement of Phillips Hall. Batch process programs may be submitted there to be run on either an IBM 360 Model 50, which is located at the Computation Center, or an IBM 360 Model 75, which is located in the nearby Research Triangle Institute. In addition the Department of Statistics has two terminals where faculty and students may program in conversation mode using APL 360, BASIC, or a modified PL-1.

Colloquia for presentation of research in both mathematical and applied statistics are held by the Departments of Statistics, Biostatistics, and Experimental Statistics. The Statistics Colloquium, which usually meets on alternate Monday afternoons throughout the academic year, is a forum for the presentation and discussion of recent developments and new ideas by statistics faculty, visiting scholars, and students. All students are expected to attend the colloquia.

ADMISSION AND FINANCIAL ASSISTANCE

Prerequisites

Admission to the Graduate School is necessarily a selective process. Only applicants with academic records of high quality should seek admission. The minimal requirement is a Bachelor of Arts or Bachelor of Science degree from an accredited college or university in this country with an average grade of B or better in the major subject, or its equivalent—based on a four year curriculum—in a foreign institution. The Department of Statistics requires additionally that foreign applicants hold first-class degrees, whenever such classifications are made.

The graduate curriculum in the Department of Statistics places strong emphasis on the mathematical theory of probability and statistics. A sound mathematical preparation is thus an essential prerequisite for admission. An applicant's mathematical background should include a one year course in advanced (multivariable) calculus or real analysis, and at least a one semester course in linear algebra and matrix theory. Introductory courses in probability and statistics are desirable but not required.

Procedures

Application forms for admission/or financial aid may be obtained by writing either to the Department of Statistics or to the Graduate School. A complete application must include at least the following:

1. The completed application forms in duplicate.
2. Two official transcripts of all previous undergraduate and graduate work.
3. Three references in duplicate (forms provided) from people familiar with the applicant's academic achievement and potential.
4. A nonrefundable application fee of $10.

In addition to the above the Department of Statistics prefers that applicants submit the following material:

5. Test scores for both the Aptitude and Advanced Mathematics Graduate Record Examinations.
6. A supplementary sheet providing brief course descriptions, including text titles where applicable, of all previous undergraduate and graduate courses in (a) probability and statistics, (b) mathematics above the level of elementary calculus, and (c) other courses of a mathematical nature, such as computer science, mathematical physics, etc.

The Graduate Record Examinations are given at regular intervals throughout the academic year at most universities in this country and in many countries abroad. Information about these examinations can usually be obtained from the dean's office of colleges or universities in this country, or by writing to Educational Testing Service, Princeton, New Jersey. Applicants for financial aid should take the examinations no later than December for admission in the succeeding fall semester.

Students whose native language is not English are required to take the Test of English as a Foreign Language Examination (TOEFL).

Financial Assistance

The Department of Statistics offers a number of Graduate Assistantships each year. These awards carry a stipend of $2800 for the academic year in addition to in-state tuition status. Graduate Assistantships are service awards requiring academically-related (non-teaching) duties not in excess of ten hours per week. Typical assignments for first or second-year students include computer programming, laboratory supervising, paper grading, or bibliographical research. Advanced students generally meet the service requirements through research on the dissertation. Duty assignments are carefully controlled to permit the student to carry a full-time degree program and to avoid delaying his academic progress.

Applicants for financial aid are considered also for various fellowships and service awards for which recipients are selected on a com-

petitive university-wide basis by the Graduate School. These awards include University First Year Fellowships and Limited Service Appointments, National Defense Education Act Title IV Fellowships, National Science Foundation Traineeships, and Morehead Fellowships. Stipends range from $2300 to $4000 for the academic year with tuition included in most cases.

Application for admission and financial aid may be made simultaneously simply by indicating on the admission application form a desire to be considered for financial aid.

Deadlines

The Department of Statistics does not admit students in the summer sessions and rarely admits students in the spring semester. The deadlines for application for admission in the fall semester are

(a) February 1 for admission and financial aid.

(b) July 1 for admission only.

Further Information

For further information about graduate programs, admission procedures, and financial aid, address inquiries to

Director of Graduate Admissions
Department of Statistics
University of North Carolina
Chapel Hill, North Carolina 27514

CURRICULUM

The Department of Statistics offers graduate courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The general requirements for these degrees are summarized in tabular form on page 23. A list and description of courses offered in the department is given later in this brochure.

Usually, three or four semesters are needed to complete a M.S. degree in statistics. This degree may be obtained with or without the writing of a thesis. Students wishing to obtain a Ph.D. in statistics normally first complete the M.S. program, if they do not already have an M.S. in statistics, and do at least one further semester of course work before embarking on research leading to the doctoral dissertation. The time needed to complete the dissertation varies considerably, depending on the student's background and initiative. However, a prospective Ph.D. candidate should normally plan to allot at least one year to this research phase of his work.

The M.S. and Ph.D. programs described in this section are the normal course programs followed by most of our students. The intent and spirit of these programs and requirements are far more important than their fine detail. Individual students have different backgrounds, needs, interests, and initiative. Accordingly, each student is encouraged to develop a suitable program in consultation with a faculty adviser, assigned to him early in his first year of study.

Normally, all students entering the department are expected to have completed at least six semester hours of advanced calculus and, preferably, to have a background in introductory probability and mathematical statistics.

Ph.D. Program

The philosophy of the Department is that its Ph.D. graduates should be "broadly based" in statistical theory and practice, and at the same time be able to conduct basic research in some special area. In order to achieve this, course work consisting of a total of approximately 60 semester hours (including "major" and "minor" fields of study) is normally required of students entering with a B.S. or equivalent degree. This will typically be reduced for students with prior graduate study in statistics or a minor field.

In his first year a student is normally required to take a standard 24 semester hours of course work involving the mathematical methods of statistics, probability, statistical theory and practice (see page 19). This year of course work provides a broad base of coverage in probability and statistical areas. Courses in this series are normally omitted only on the grounds of prior knowledge and demonstrated competence in the subject material.

In his second year a student takes advanced courses in which he may specialize his area of interest. Five main areas of specialization are currently recognized: Inference, Probability, Design of experiments, Multivariate Analysis, Communication Theory. A student wishing to specialize in a given area should take advanced courses in his area during his second and third years, prior to and during his research for his dissertation. In addition a student is asked to take (typically three) advanced courses in other areas of statistics in order to broaden his area of competence.

Fifteen hours of course work in a "minor" field are required for all students. Some of this may be "transferred" from graduate work at another institution. The fifteen hours required may be taken as a "supporting program," the content of which may be approved by this department, or as a "formal minor," which requires the approval of the minor department also. (The advantage of a formal minor is that it is recognized by the university on a student's record.)

For a formal minor, all of the fifteen hours required must be taken from courses in (or cross-listed with) another department. (Present departmental policy precludes the counting of more than 3 hours from cross-listed courses which are primarily given by this department—e.g., Statistics 112, 102, etc.) The requirements for a supporting program are the same, except that in special cases a statistics course which is not cross-listed elsewhere may be approved for use as the three hours from courses given in this department (e.g., Statistics 140), for students specializing in communication theory or probability.

A detailed listing of appropriate courses for students in each area of specialization is given in the following table.

Typical course work for students specializing in each area*

1. First year (all students)
   Fall Stat. 111, 112, 134 Spring Stat. 102, 132, 135, 150.
2. Following years (by area)

A. Inference

"Major"	*"Broadening"*
220	210
221	235
222	260 (140)
231	
232	

*Except for the first year courses, the courses listed in this table, and especially the "Broadening" courses, are by no means required. They are given as examples of typical curricula.

B. Design

210	180
251	222
253	220
254	
260	

C. Multivariate Analysis

260	180
261	222
262	220
210	
200	

D. Probability

231	220
235	222
237	252
331	

E. Communication Theory

140	231
142	220
242	252
245	
235	

Minor/Supporting Program:

For the probability area with Math supporting program fifteen hours of *Mathematics Department* courses or twelve hours and Statistics 140, is encouraged.

For communication theory Statistics 140 may serve as the three hours of departmental course work in a supporting program.

M.S. Program

The M.S. degree in statistics may be obtained with or without writing a thesis. The writing of an essay on a topic in statistics and registration in one semester of Statistics 300-301 (Seminar in Statistical Literature), in which each student is required to present at least one paper from the literature, may be substituted for the thesis requirement of the M.S. degree. Thus, students who plan to proceed toward a Ph.D. in statistics may also obtain an M.S. degree without any undue interruption of their program of study.

Students who plan to take only a Master's degree are normally required to take all the first year courses listed above, with the exception of Statistics 112, and must take at least one 200 level course. Specially recommended courses for these students are Statistics 180 (Methods of Operations Research), Statistics 210 (Design and Analysis of Experiments), Statistics 260 (Multivariate Analysis), and Computer and Information Science 150 (Numerical Analysis).

Candidates for a Master's degree must complete 9 to 12 hours of study in a related minor field. There are a number of possible minor fields—mathematics, applied statistics, public health, economics, psychometrics, city and regional planning, a physical, biological or a social science, or a combination of two such fields. Some courses within the Department may be counted towards a minor.

A suitable minor should be planned with the student's adviser.

Written Examinations

Both master's and doctoral students are required to pass the basic written examinations, at the appropriate level. These are normally taken in the fall of the second year and are usually given during one week in November. The examinations consist of three closed-book comprehensive written examinations, each three hours in length, covering the material in the first year courses. Paper I is based on courses 111, 112, and 134; Paper II, on 132, 135, 102 and 150; Paper III is a practical examination, based on courses 134, 135, 102 and 150, and is intended to test a student's ability to perform statistical calculations and his powers of interpretation. Students with an undergraduate major in engineering, and with a sufficient background in complex variables and Fourier theory, may be permitted to substitute 140, 142 and 252 for 111, 102 and 150.

Oral Examinations

At the M.S. oral examinations, the student will present orally his thesis or essay and submit to questioning thereon, be examined on his minor field, and be examined on any topics in his major field of study in which previous weaknesses have been shown.

The doctoral preliminary oral examination is normally taken during the early stages of the student's research program. At this examination, the student will describe his proposed dissertation topic, be questioned on a predetermined reading list oriented towards his area of research, be examined orally on his minor field, and be questioned on any deficiencies in his major as disclosed by the written examinations.

Foreign Language Requirements

For the M.S. degree, a student will be required to demonstrate reading knowledge of one modern language other than English which is useful for reading scholarly papers in statistics. For the Ph.D. degree, reading knowledge of two such languages is required. Note: A student whose native language is not English may present his own language to

satisfy this requirement, provided that it is recognized by the Department as being a useful language for statistical research.

Foreign Students

Foreign students whose native language is not English will be required to take an English examination, administered by the University, before registration is completed. If the performance is not satisfactory, remedial study will be required before pursuing a full-time graduate program.

SUMMARY OF GRADUATE REQUIREMENTS IN STATISTICS

The following outline gives a brief summary of the requirements for master's and doctoral degrees in statistics. Incorporated into this outline are the general requirements of the Graduate School and the specific requirements of the Department of Statistics. Detailed requirements of the Graduate School are given in the Graduate School Catalog.

DEGREE	M.S. (with thesis)	M.S. (non-thesis)	Ph.D.
Requirements for admission	A bachelor's degree from an accredited university or college with thorough training in mathematics, including at least six semester hours of advanced calculus.	Same	Same
Course Requirements	1. 21 credits in statistics 2. 9 credits in the minor or supporting program 3. Supporting mathematics courses as necessary (See page 18 for curriculum details)	1. 21 credits in statistics 2. 9 credits in the minor or supporting program 3. Supporting mathematics courses as necessary 4. Registration in Stat. 300 or 301 (See page 18 for curriculum details)	1. Approximately 45 credits of graduate statistics courses 2. 15 credits in the minor or supporting program (See page 18 for curriculum details)
Thesis	A thesis is required (3-6 credits). It must represent an original investigation but need not constitute a contribution to the theory of statistics.	An essay on a topic in statistics, under the direction of one of the faculty, is required.	A dissertation containing a substantial original contribution to the theory of statistics or applied statistics is required. Publication of the dissertation is expected.
Language Requirements	Reading knowledge of one modern foreign language.	Reading knowledge of one modern foreign language	Reading knowledge of two modern foreign languages.
Written Examinations	Basic written examinations based on first year courses, generally taken in fall of second year.	Basic written examinations based on first year courses, generally taken in fall of second year.	Basic written examinations based on first year courses, generally taken in fall of second year.
Oral Examinations	Oral examination on thesis, minor field of study and any topics in major field.	Oral examination covering entire field of study and oral presentation of essay.	1. Preliminary oral examination taken at or near conclusion of course work, covering dissertation topic, minor and any deficiencies in major disclosed by written examinations 2. Final oral examination after completion of dissertation, concerning entire field of study and dissertation
Time required for completion	Usually 3-4 semesters	Usually 3-4 semesters	Usually at least 3 years after entering department

COURSES

11 BASIC CONCEPTS OF STATISTICS AND DATA ANALYSIS (3). No prerequisite. Basic concepts and techniques of data analysis emphasizing the role of statistics in making inferences, predictions, and decisions from data. Includes the use of computers. *Fall and spring.* Staff.

12 BASIC CONCEPTS OF STATISTICS AND PROBABILITY (3). No prerequisite. An elementary introduction to probability and statistical inference. *Fall and spring.* Staff.

100 PRINCIPLES OF STATISTICAL INFERENCE (3). Prerequisite, college algebra. Fundamental concepts of modern statistics for students who plan to conduct research, use research results, or make decisions from data. Emphasis on principles and methods. *Fall and spring.* Nicholson.

101 ELEMENTS OF PROBABILITY AND STATISTICAL INFERENCE (3). Prerequisite, integral calculus. Fundamentals of probability theory; descriptive statistics; fundamentals of statistical inference, including estimation and hypothesis testing. *Fall and spring.* Cleveland, W. K. Smith.

102 ELEMENTS OF STATISTICAL ANALYSIS (3). Prerequisite, Statistics 101. Various topics in statistical methods, including applied regression analysis, analysis of simple experimental designs, data analysis. *Spring.* Cleveland, Wegman.

103 DESIGN AND ANALYSIS OF EXPERIMENTS (3). Prerequisite, Statistics 101. Methods in planning, design, and analysis of experiments. *Spring.* K. J. C. Smith.

111 METHODS OF MATHEMATICAL STATISTICS (3). Prerequisite, advanced calculus. Introductory treatment of special mathematical techniques of particular importance in probability and statistics, including complex variables, Fourier and Laplace transforms, elements of finite difference equations. *Fall.* Baker, Shachtman.

112 MEASURE AND INTEGRATION (3). Prerequisite, advanced calculus. Lebesgue and abstract measure and integration, convergence theorems, differentiation, Radon-Nikodym theorem, product measures, Fubini theorem. L^p-spaces. *Fall and spring.* Staff.

126 INTRODUCTION TO PROBABILITY (Mathematics 146) (3). Prerequisite, integral calculus. Introduction to mathematical theory of probability covering random variables, moments, binomial, Poisson, normal and related distributions, generating functions, sums and sequences of random variables, and statistical applications. *Fall and spring.* Kelly.

127 MATHEMATICAL STATISTICS (3). Prerequisite, Statistics 126 or equivalent. Functions of random samples and their probability distributions; introductory theory of point and interval estimation, and of hypothesis testing; elementary decision theory. *Fall and spring.* Shachtman, Simons.

128 LINEAR STATISTICAL MODELS (3). Prerequisite, Statistics 127. An introductory mathematical treatment of linear statistical models, the theory of least squares, the analysis of variance, their applications to experimental designs, and related topics in experimental statistics. *Fall.* Dowling.

129 INTRODUCTION TO STOCHASTIC PROCESSES (3). Prerequisites, Statistics 126. Elementary theory and application of random process models;

recurrent events, random walks. Markov chains. Poisson processes, birth-and-death processes, queueing processes. *Fall and spring.* W. K. Smith, Shachtman.

132 INTERMEDIATE PROBABILITY (3). Prerequisite, Statistics 112 or permission of instructor. Foundations of probability. Basic classical theorems. Modes of probabilistic convergence. Central limit problem. Generating functions, characteristic functions. Introduction to stochastic processes. *Spring.* Leadbetter, Wegman, W. K. Smith.

133 INTRODUCTION TO TIME SERIES ANALYSIS (3). Prerequisite, Statistics 126. Topics chosen from: Time series data analysis. Fitting parametric models, such as regression-autoregression models to time series. Spectrum analysis. Filtering. *Spring and fall.* Cleveland, Wegman.

134 INTERMEDIATE STATISTICAL THEORY I (6). Prerequisite, two semesters of advanced calculus. Fundamentals of probability and distribution theory including: axiomatic treatment of probability, independence, random variables, regression theory, convergence and approximation, common distributions. *Four and one-half lecture hours a week. Fall.* Simons, W. L. Smith.

135 INTERMEDIATE STATISTICAL THEORY II (3). Prerequisite, Statistics 134 or equivalent. Fundamentals of statistical inference including: sufficient statistics, point estimation, hypothesis testing, chi-square tests. Linear estimation, analysis of variance and regression are largely excluded (see Statistics 150). *Spring.* Simons, W. L. Smith.

140 LINEAR SYSTEMS (3). Prerequisite, Statistics 111; linear algebra and the elements of measure and integration helpful. Hilbert space theory, including Hilbert space geometry, bounded linear operators, spectral representations, compact operators, applications. Representations of signals and linear systems, including impulse response, transfer functions, state variables. *Fall.* Cambanis.

142 INTRODUCTION TO ESTIMATION AND DETECTION THEORY (3). Prerequisites, Statistics 134 and 140; elements of stochastic processes desirable. The Wiener-Kolmogorov and the Kalman-Bucy filtering theories. Modulation theory. Basic problems of detection theory. *Spring.* Cambanis.

150 ANALYSIS OF VARIANCE WITH APPLICATION TO EXPERIMENTAL DESIGNS (3). Corequisite, Statistics 135. Linear estimation. Gauss-Markoff theorem. Sums of squares. Analysis of variance and generalized t and F tests. Intrablock analysis of incomplete block designs. Balanced, lattice and Latin square designs. *Spring.* Chakravarti.

156 COMBINATORIAL MATHEMATICS (Mathematics 148) (3). Prerequisites, Mathematics 135 or 136, Mathematics 121 or permission of the instructor. Topics chosen from: Generating functions, Polya's theory of counting, partial orderings and incidence algebras, principle of inclusion-exclusion. Mobius inversion, combinatorial problems in physics and other branches of science. *Fall.* Kelly.

158 INTRODUCTION TO GRAPH THEORY (Mathematics 149) (3). Prerequisite, linear algebra. Basic concepts of directed and undirected graphs. Connectivity, traversability, and factorization of graphs. Planar graphs. Extremal problems. Automorphism group of a graph. Matrix representations. Coloring problems and the chromatic polynomial. *Spring.* Dowling.

160 MULTIVARIATE ANALYSIS (3). Prerequisite, Statistics 127. Introduction to the established theory of the multivariate normal distribution including estimation, hypothesis testing, and classification problems; correlation; generalized T^2; multivariate analysis of variance; canonical correlation and other standard topics. *Fall.* Johnson, Chakravarti.

170 ORDER STATISTICS (3). Prerequisite, Statistics 127. Distribution and moments of order statistics. Estimation of location and scale parameters, censoring. Robust estimation. Short-cut procedures. Treatment of outliers. Extreme-value theory. (1971-1972 and alternate years.) *Spring.* David.

171 INTRODUCTION TO NONPARAMETRIC STATISTICS (3). Prerequisites, Statistics 102, and basic courses in statistical theory. Sign test, rank sum tests, rank correlation methods, order statistics, Kolmogorov-Smirnov goodness-of-fit tests, Fisher-Pitman randomization theory, k-sample tests, method of paired comparisons, power and asymptotic relative efficiency. *Fall.* Quade.

180 STOCHASTIC MODELS IN OPERATIONS RESEARCH (3). Prerequisite, Statistics 126. Introduction to queueing theory (substantial), Markovian sequential decision process, inventory theory and topics from stochastic linear programming, simulation, scheduling, game theory. Applications. *Fall and spring.* Shachtman, Nicholson.

181 DETERMINISTIC MODELS IN OPERATIONS RESEARCH (3). Prerequisite, Mathematics 147. Linear, integer, non-linear and dynamic programming, classical optimization problems, network theory. *Fall and spring.* Gould, Nicholson, Shachtman.

200 APPLIED MULTIVARIATE ANALYSIS I (2). Prerequisite, Statistics 135. Relations between multiple regression, analysis of variance, multivariate analysis and factor analysis. Principal components. Discriminant analysis. Canonical analysis. Scaling methods. Classification problems. Cluster analysis. *Spring.* Johnson.

210 DESIGN AND ANALYSIS OF EXPERIMENTS (3). Prerequisites, Statistics 102 and 150. The principles of the design and analysis of experiments. Randomization, replication, local control. Randomized blocks. Latin and Graeco-Latin squares, factorial experiments. Confounding, fractional factorials, split plots, recent developments. *Fall.* Johnson.

220 THEORY OF ESTIMATION AND HYPOTHESIS TESTING (4). Prerequisites, Statistics 132, 135. Bayes procedures for estimation and testing. Minimax procedures. Unbiased estimators. Unbiased tests and similar tests. Invariant procedures. Sufficient statistics. Confidence sets. Large sample theory. *Fall.* Hoeffding.

221 SEQUENTIAL ANALYSIS (3). Prerequisites, Statistics 132 and 135. Hypothesis testing and estimation when the sample size depends on the observations. Sequential probability ratio tests. Sequential design of experiments. Optimal stopping. Stochastic approximation. *Fall.* Simons.

222 NONPARAMETRIC INFERENCE (3). Prerequisites, Statistics 132, 135 and 112. Estimation and testing when the functional form of the population distribution is unknown. Rank, sign, and permutation tests. Optimum non-parametric tests and estimators. *Spring.* Hoeffding.

231 ADVANCED PROBABILITY (3). Prerequisites, Statistics 132, 112. Advanced theoretic course, covering topics selected from: central limit theo-

rems, laws of large numbers, stable laws, infinitely divisible laws, random walks, martingales. *Fall.* W. L. Smith, Simons.

232 GENERAL THEORY OF STATISTICAL DECISION (3). Prerequisites, Statistics 135 and 112. Selected topics in the general theory of statistical decisions, based on the work of Abraham Wald. (1969-1970 and alternate years.) *Spring.* Hoeffding.

235 STOCHASTIC PROCESSES (3). Prerequisites, Statistics 112 and 132. Advanced theoretic course including topics selected from: Foundations of stochastic processes, Renewal processes, Stationary processes, Markov processes, Martingales, Point processes. (1969-1970 and alternate years.) *Spring.* Leadbetter, W. L. Smith.

237 TIME SERIES ANALYSIS (3). Prerequisites, Statistics 112, 132. Analysis of time series data by means of particular models such as autogressive and moving average schemes. Spectral theory for stationary processes and associated methods for inference. Stationarity testing. (1970-1971 and alternate years.) *Spring.* Leadbetter, Wegman, Cleveland.

242 ADVANCED DETECTION AND ESTIMATION THEORY (3). Prerequisites, Statistics 235 and 140. Singular detection problems, determination of the likelihood ratio for non-singular detection, non-parametric detection, non-linear filtering theory. *Spring.* Baker.

245 ADVANCED TOPICS IN STATISTICAL COMMUNICATION THEORY (3). Prerequisites, Statistics 142, 242 and 252. Topics of current research interest. *Fall.* Baker.

251 COMBINATORIAL PROBLEMS OF THE DESIGN OF EXPERIMENTS (3). Prerequisite, Statistics 150. Finite fields and finite geometries. Construction of orthogonal Latin squares and balanced incomplete block designs. Confounding, construction and analysis of symmetrical and functional factorial designs. *Fall.* Bose.

252 INFORMATION THEORY (3). Prerequisite, Statistics 134. Transmission of information, entropy, message ensembles, discrete sources, transmission channels, channel encoding and decoding for discrete channels. *Spring.* Rajput.

253 ERROR CORRECTING CODES (3). Prerequisite, Statistics 251, or permission of the instructor. Linear codes and their error-correcting capabilities. Hamming codes. Reed-Muller codes. Cyclic codes. Bose-Chaudhuri codes. Burst error correction. Majority logic decoding. *Spring.* Bose.

254 SPECIAL TOPICS IN DESIGN OF EXPERIMENTS I (3). Prerequisite, Statistics 150. Response surface designs. Conditions for rotatability. Construction and analysis of rotatable designs of the second and third order. Interblock analysis. General analysis of covariance. Missing plot techniques. *Fall.* Bose.

255 SPECIAL TOPICS IN THE DESIGN OF EXPERIMENTS II (3). Prerequisite, Statistics 251. Combinatorial properties and construction of balanced, group divisible and partially balanced designs. Impossibility proofs. Orthogonal Latin squares of non-prime power orders. Orthogonal arrays. Asymmetrical fractionally replicated designs. *Spring.* Bose.

260 MULTIVARIATE ANALYSIS (3). Prerequisites, Statistics 135 and matrices. Characterization and properties of a multivariate normal distribution.

Related distributions. Tests and confidence intervals. Multivariate analysis of variance, covariance and regression. Association between subsets of a multivariate normal set. Factor analysis. *Fall.* Johnson.

261 ADVANCED PARAMETRIC MULTIVARIATE ANALYSIS (3). Prerequisite, Statistics 260. Distribution problems involved in the normal theory analysis of general multivariate linear models including the growth curves. An introduction to zonal polynomials and orthogonal groups. Union-intersection principle and its role in multivariate analysis. (1970-1971 and alternate years.) *Spring.* Sen.

262 INTRODUCTORY NONPARAMETRIC MULTIVARIATE ANALYSIS (3). Prerequisite, Statistics 222 and 260. The problem of symmetry in the multivariate case. Nonparametric tests for ANOVA and MANOVA in one-way layouts. Robust estimation of location and of contrasts in one-way MANOVA. Large sample properties of the tests and estimates. *Fall.* Sen.

263 ADVANCED NONPARAMETRIC MULTIVARIATE ANALYSIS (3). Prerequisite, Statistics 262. Robust nonparametric inference in various multifactor multiresponse experiments. The problem of multidimensional independence. Nonparametric inference in general linear models. (1971-1972 and alternate years.) *Spring.* Sen.

300-301 SEMINAR IN STATISTICAL LITERATURE (1 each). Prerequisite, Statistics 135. *Fall and spring.* Staff.

310-311 SEMINAR IN THEORETICAL STATISTICS (3 each). Prerequisite, Statistics 135. *Fall and spring.* Staff.

321-322 SPECIAL PROBLEMS (3 each). Prerequisite, permission of the instructor. *Fall and spring.* Staff.

331-332 ADVANCED RESEARCH (3 each). Prerequisite, permission of the instructor. *Fall and spring.* Staff.

393 MASTER'S THESIS (3 or more). Prerequisite, permission of the student's adviser. *Fall and spring.* Staff.

394 DOCTORAL DISSERTATION (3 or more). Prerequisite, permission of the student's adviser. *Fall and spring.* Staff.

400 GENERAL REGISTRATION.

DEGREES AWARDED

	1948-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70
M.S.	17	1	0	1	1	4	5	2
Ph.D.	72	4	0	6	3	5	8	4

RECENT DISSERTATIONS

Optimal response surface techniques using Fourier series and spherical harmonics
Estimation and hypothesis testing for generalized multivariate linear models
Multitype branching processes in random environments
A sequential fixed-width confidence interval for the mean of a U-statistic
On minimizing the risk in certain sequential tests, for known or unknown cost
Contributions to partially balanced weighing designs
Rank tests invariant only under linear transformations
Canonical analysis of several sets of variables
On the renewal density matrix of a semi-Markov process
Some aspects of linear prediction in stationary time series

OPERATIONS RESEARCH AND SYSTEMS ANALYSIS CURRICULUM

The Department of Statistics is one of the core departments supporting the Operations Research and Systems Analysis (O.R.S.A.) Curriculum at the University. This Curriculum is a separate program offering the M.S. and Ph.D. degrees. In addition, degree candidates in statistics may elect a minor or supporting program in O.R.S.A.

The study of O.R.S.A. involves the application of diverse topics in mathematics and statistics to problems of resource allocation. At Chapel Hill, specialization is possible in theoretic areas (for example, Mathematical Programming, Stochastic Processes) or through specific applications (such as Urban and Environmental Systems, Population Studies, Biological Sciences).

For further information and/or applications for admission and financial aid, please write to:

Chairman
Operations Research and Systems Analysis
315 Phillips Hall
University of North Carolina
Chapel Hill, North Carolina 27514

ADDITIONAL INFORMATION

Tuition and Fees

For full-time graduate students holding service awards, tuition and fees are payable at the current in-state rate of $398.00 for the academic year. Tuition and fees for out-of-state students are presently $1,123.00 per year. Most fellowship stipends include tuition and fees.

Residence Status for Tuition Payment

1. *General:* The tuition charge for legal residents of North Carolina is less than for nonresidents. To qualify for in-state tuition, a legal resident must have maintained his domicile[1] in North Carolina for at least the six months next preceding the date of first enrollment or re-enrollment in an institution of higher education in this State.

2. *Minors:* The legal residence of a person under twenty-one years of age at the time of his first enrollment in an institution of higher education in this State is that of his parents, surviving parent, or legal guardian. In cases where parents are divorced or legally separated, the legal residence of the father will control unless custody of the minor has been awarded by court order to the mother or to a legal guardian other than a parent. No claim of residence in North Carolina based upon residence of a guardian in North Carolina will be considered if either parents is living unless the action of the court appointing the guardian antedates the student's first enrollment in a North Carolina institution of higher education by at least twelve months.

   A minor student whose parents move their legal residence from North Carolina to a location outside the State shall be considered to be a non-resident after six months from the date of removal from the State.

   For the purpose of determining residence requirements under these rules, a person will be considered a minor until he has reached his twenty-first birthday. Married minors, however, are entitled to establish and maintain their residence in the same manner as adults. Attendance at an institution of higher education as a student cannot be counted as fulfilling the six-month domicile requirement.

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1. Domicile is synonymous with legal residence. A person's domicile is his permanent dwelling place. It is the place where he is generally understood to reside with the intention of remaining there indefinitely or of returning there when absent. It is presumed that a person whose domicile is in North Carolina is registered to vote, files a North Carolina State Income Tax and other reports, and complies with other obligations of persons resident in North Carolina.

3. *Adults:* A person twenty-one years of age or older is eligible for in-state tuition if he has maintained continuous domicile in North Carolina for the six months next preceding the date of enrollment or re-enrollment, exclusive of any time spent in attendance at any institution of higher education. An in-state student reaching the age of twenty-one is not required to re-establish residence provided that he maintains his domicile in North Carolina.

4. *Married Students:* The legal residence of a wife follows that of her husband, except that a woman currently enrolled as an in-state student in an institution of higher education may continue as a resident even though she marries a nonresident. If the husband is a nonresident and separation or divorce occurs, the woman may qualify for in-state tuition after establishing her domicile in North Carolina for at least six months under the same conditions as she could if she were single.

5. *Military Personnel:* No person shall be presumed to have gained or lost in-state residence status in North Carolina while serving in the Armed Forces. However, a member of the Armed Forces may obtain in-state residence status for himself, his spouse, or his children after maintaining his domicile in North Carolina for at least the six months next preceding his or their enrollment or re-enrollment in an institution of higher education in this State.

6. *Aliens:* Aliens lawfully admitted to the United States for permanent residence may establish North Carolina residence in the same manner as any other non-resident.

7. *Property and Taxes:* Ownership of property in or payment of taxes to the State of North Carolina apart from legal residence will not qualify one for the in-state tuition rate.

8. *Change of Status:*[2] The residence status of any student is determined as of the time of his first enrollment in an institution of higher education in North Carolina and may not thereafter be changed except: (a) in the case of a nonresident student at the time of his first enrollment who, or if a minor his parents, has subsequently maintained a legal residence in North Carolina for at least six months, and (b) in the case of a resident who has

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2. To qualify for in-state tuition, a legal resident must have maintained his domicile in North Carolina for at least six months next preceding the date of first enrollment or re-enrollment in an institution of higher education in the State. Attendance at an institution of higher education as a student cannot be counted as fulfilling the six-month domicile requirement. A person twenty-one years of age or older is eligible for in-state tuition if he has maintained continuous domicile in North Carolina for the six months next preceding the date of enrollment or re-enrollment, exclusive of any time spent in attendance at any institution of higher education.

abandoned his legal residence in North Carolina for a minimum period of six months. In either case, the appropriate tuition rate will become effective at the beginning of the term following the six-month period.

9. *Responsibility of Student:* Any student or prospective student in doubt concerning his residence status must bear the responsibility for securing a ruling by stating his case in writing to the admissions officer. The student who, due to subsequent events, becomes eligible for a change in classification, whether from out-of-state to in-state or the reverse, has the responsibility of immediately informing the Office of Admissions of this circumstance in writing. Failure to give complete and correct information regarding residence constitutes grounds for disciplinary action.

10. *Appeals of Rulings of Admission Officers:* Any student or prospective student may appeal the ruling of the admissions officer in writing to the Chancellor of the institution. The Chancellor may use any officer or committee which he deems appropriate in review of the appeal. Appeal of the Chancellor's ruling may be made to the President of the University; such appeals to be filed with the Chancellor and forwarded by him to the President.

Housing

The University provides limited housing for unmarried students in residence halls, several of which are reserved for graduate students. The cost per academic year is $312-$580. Laundry and linen services are available at reasonable rates. Further information about housing may be found in the Graduate School Catalog. Dining facilities are operated in locations convenient to residence halls and meals are offered at reasonable rates.

The University has several hundred apartments available for married students, consisting of one bedroom and two bedroom units. Rent is approximately $82 to $110 per month, while rent in the older prefabricated units is considerably lower. It is a general policy of the University to grant priority to married graduate students. Early application to the Director of Housing is strongly recommended.

Apart from University housing, there are privately operated residence halls in University Square. These buildings have a cafeteria dining commons and the fee charged includes room and board. Arrangements for these accommodations should be made directly with the Granville Towers Business Office, University Square, Chapel Hill, N. C. 27514.

Policies, Procedures, and Disciplinary Actions In Cases of Disruption of Educational Process

The following statement has been incorporated in the By-Laws of the Board of Trustees of the University, and is quoted for the information of all members of the University Community.

Section 5-1. Policies Relating to Disruptive Conduct

The University of North Carolina has long honored the right of free discussion and expression, peaceful picketing and demonstrations, the right to petition and peaceably to assemble. That these rights are a part of the fabric of this institution is not questioned. They must remain secure. It is equally clear, however, that in a community of learning willful disruption of the educational process, destruction of property, and interference with the rights of other members of the community cannot be tolerated. Accordingly, it shall be the policy of the University to deal with any such disruption, destruction or interference promptly and effectively, but also fairly and impartially without regard to race, religion, sex or political beliefs.

Section 5-2. Definition of Disruptive Conduct

(a) Any faculty member (the term "faculty member," wherever used in this Chapter V, shall include regular faculty members, full-time instructors, lecturers, and all other persons exempt from the North Carolina State Personnel System [Chapter 126 of the General Statutes as amended] who receive compensation for teaching, or other

Housing for Married Students

instructional functions, or research at the University), any graduate student engaged in the instructional program, or any student who, with the intent to obstruct or disrupt any normal operation or function of the University or any of its component institutions, engages, or incites others to engage, in individual or collective conduct which destroys or significantly damages any University property, or which impairs or threatens impairment of the physical well-being of any member of the University community, or which, because of its violent, forceful, threatening or intimidating nature or because it restrains freedom of lawful movement, otherwise prevents any member of the University community from conducting his normal activities within the University, shall be subject to prompt and appropriate disciplinary action, which may include suspension, expulsion, discharge or dismissal from the University.

The following, while not intended to be exclusive, illustrate the offenses encompassed herein, when done for the purpose of obstructing or disrupting any normal operation or function of the University or any of its component institutions: (1) occupation of any University building or part thereof with intent to deprive others of its normal use; (2) blocking the entrance or exit of any University building or corridor or room therein with intent to deprive others of lawful access to or from, or use of, said building or corridor or room; (3) setting fire to or by any other means destroying or substantially damaging any University building or property, or the property of others on University premises; (4) any possession or display of, or attempt or threat to use, for any unlawful purpose, any weapon, dangerous instrument, explosive, or inflammable material in any University building or on any University campus; (5) prevention of, or attempt to prevent by physical act, the attending, convening, continuation or orderly conduct of any University class or activity or of any lawful meeting or assembly in any University building or on any University campus; and (6) blocking normal pedestrian or vehicular traffic on or into any University campus.

(b) Any person engaged in the instructional program who fails or refuses to carry out validly assigned duties, with the intent to obstruct or disrupt any normal operation or function of the University or any of its component institutions, shall be subject to prompt and appropriate disciplinary action under this Chapter V if (but only if) his status is such that he is not subject to the provisions of Section 4-3 of Chapter IV.

Section 5-3. Responsibilities of Chancellors

(a) When any Chancellor has cause to believe that any of the provisions of this Chapter V have been violated, he shall forthwith investigate or cause to be investigated the occurrence, and upon

identification of the parties involved shall promptly determine whether any charge is to be made with respect thereto.

(b) If he decides that a charge is to be made, he shall, within thirty (30) days after he has information as to the identity of the alleged perpetrator of the offense but in no event more than twelve (12) months after the occurrence of the alleged offense, (i) refer the case to the appropriate existing University judicial body, or (ii) refer the matter to a Hearing Committee drawn from a previously selected Hearings Panel which, under this option, is required to implement action for violation of Section 5-2 (a) or (b) of this Chapter. If the case is referred to an existing University judicial body under (i) above, the procedural rules of that body shall be followed, and subsections (c) through (f) below shall not be applicable. If the matter is referred to a Hearing Committee under (ii) above, the procedural rules prescribed in subsections (c) through (f) below shall be followed.

(c) The accused shall be given written notice by personal service or registered mail, return receipt requested, stating:

(1) The specific violations of this Chapter V with which the accused is charged.

(2) The designated time and place of the hearing on the charge by the Hearing Committee, which time shall not be earlier than seven (7) nor later than ten (10) days following receipt of the notice.

(3) That the accused shall be entitled to the presumption of innocence until found guilty, the right to retain counsel, the right to present the testimony of witnesses and other evidence, the right to cross-examine all witnesses against him, the right to examine all documents and demonstrative evidence adverse to him, and the right to a transcript of the proceedings of the hearing.

(d) The Hearing Committee shall determine the guilt or innocence of the accused. If the person charged is found guilty, the Hearing Committee shall recommend to the Chancellor such discipline as said body determines to be appropriate. After considering such recommendation the Chancellor shall prescribe such discipline as he deems proper. In any event, whether the person is found guilty or not guilty, a written report shall be made by the Chancellor to the President within ten (10) days.

(e) Any person found guilty shall have ten (10) days after notice of such finding in which to appeal to the President of the University. Such an appeal if taken shall be upon the grounds set forth in Section 5-5.

(f) Any accused person who, without good cause, shall fail to appear at the time and place fixed for the hearing of his case by the Hearing Committee shall be suspended indefinitely or discharged from University employment.

(g) A Chancellor, unless so ordered or otherwise prevented by court, shall not be precluded from carrying out his duties under this Chapter V by reason of any pending action in any State or Federal court. Should a delay occur in prosecuting the charge against the accused because the accused or witnesses that may be necessary to a determination of the charge are involved in State or Federal court actions, the time limitations set forth above in this Section 5-3 shall not apply.

(h) Conviction in any State or Federal court shall not preclude the University or any of its officers from exercising disciplinary action in any offense referred to in this Chapter V.

(i) Nothing contained in this Chapter V shall preclude the President or any Chancellor from taking any other steps, including injunctive relief or other legal action, which he may deem advisable to protect the best interests of the University.

Section 5-4. Aggravated Acts or Threatened Repetition of Acts

(a) The Chancellor of each of the component institutions of the University shall appoint an Emergency Consultative Panel which shall be composed of not less than three (3) nor more than five (5) faculty members and not less than three (3) nor more than five (5) students who shall be available to advise with the Chancellor in any emergency. No member of such Panel shall serve for more than one (1) year unless he be reappointed by the Chancellor. The Chancellor may make appointments, either temporary or for a full year, to fill any vacancies which may exist on the Panel.

(b) If, in the judgment of the Chancellor, there is clear and convincing evidence that a person has committed any of the acts prohibited under this Chapter V which, because of the aggravated character or probable repetition of such act or acts, necessitates immediate action to protect the University from substantial interference with any of its orderly operations or functions, or to prevent threats to or acts which endanger life or property, the Chancellor, with the concurrence as hereinafter provided of the Emergency Consultative Panel established pursuant to (a) above, may forthwith suspend such person from the University and bar him from the University campus; provided, however, that in the event of such suspension the person suspended shall be given written notice of the reason for his suspension, either personally or by registered mail addressed to his last known addresses, and shall be afforded a prompt hearing,

which, if requested, shall be commenced within ten (10) days of the suspension. Except for purposes of attending personally any hearings conducted under this Chapter V, the bar against the appearance of the accused on the University campus shall remain in effect until final judgment has been rendered in his case and all appellant proceedings have been concluded, unless such restriction is earlier lifted by written notice from the Chancellor.

(c) A quorum of the Emergency Consultative Panel provided for in (a) above shall consist of not less than four (4) of its members, and the required concurrence shall have been obtained if a majority of such quorum shall indicate their concurrence. The Chancellor shall meet personally with members of such Panel at the time he seeks concurrence, if it is feasible to do so. However, if the circumstances are such that the Chancellor deems it not to be feasible to personally assemble such members, then he may communicate with them or the required number of them individually by telephone or by such other means as he may choose to employ, in which event he may proceed as provided in (b) above after the required majority of such members have communicated their concurrence to him.

(d) In the Chancellor's absence or inability to act, the President may exercise the powers of the Chancellor specified in this Section 5-4 in the same manner and to the same extent as could the Chancellor but for such absence or inability to act.

Section 5-5. Right of Appeal

Any person found guilty of violating the provisions of this Chapter V by the Hearing Committee referred to in Section 5-3 shall have the right to appeal the finding and the discipline imposed upon him to the President of the University. Any such appeal shall be in writing, shall be based solely upon the record, and shall be limited to one or more of the following grounds:

(1) That the finding is not supported by substantial evidence;

(2) That a fair hearing was not accorded the accused; or

(3) That the discipline imposed was excessive or inappropriate.

It shall be the responsibility of the President to make prompt disposition of all such appeals, and his decision shall be rendered within thirty (30) days after receipt of the complete record on appeal.

Section 5-6. No Amnesty

No administrative official, faculty member, or student of the University shall have authority to grant amnesty or to make any promise as to prosecution or non-prosecution in any court, State or Federal, or before any student, faculty, administrative, or Trustee committee

to any person charged with or suspected of violating Section 5-2 (a) or (b) of these Bylaws.

Section 5-7. Publication

The provisions of this Chapter V shall be given wide dissemination in such manner as the President or Chancellors may deem advisable, and shall be printed in the official catalogues which may be issued by each component institution of the University.

Procedures for Use in Case of Refusal by Graduate Student Service Appointees Who Are Not Subject to Code Section 4-3 To Perform Validly Assigned Duties

The following statement has been promulgated by the University Administration and is quoted for the information of all members of the University Community.

In the event that any graduate student fails or refuses to carry out validly assigned duties with the intent to obstruct or disrupt any normal operation or function of the University, the procedures given below will be followed. In these procedures the term "dean" identifies the deans of professional schools.

I. Administrative Procedures

1. The dean or department chairman in whose school or department the graduate student is appointed will immediately inquire into the alleged conduct. He shall, in writing, notify the graduate student involved that he is beginning an inquiry into the alleged conduct, which shall be briefly described. On the basis of his inquiry, he shall make a concise written finding of fact with respect to whether it appears that there did occur a failure or refusal to carry out validly assigned duties with the intent to obstruct or disrupt any normal operation or function of the University. He shall transmit one copy of the finding to the Chancellor and one to the graduate student involved.

2. If the inquiry indicates that the graduate student has failed or refused to carry out validly assigned duties with the intent to obstruct or disrupt any normal operation or function of the University, then the dean or chairman shall suspend the graduate student with pay from all duties until (a) the Chancellor has determined that no charge is to be made with respect thereto or (b) a final decision with respect thereto has been reached following a hearing before the body to which the matter is referred by the Chancellor.

3. If the Chancellor decides that a charge is to be made with respect to the matter and that it is to be referred to the appropriate existing University judicial body (rather than to the Hearing Com-

mittee referred to in Code Section 5-3), it shall be handled in the manner set forth below.

II. Hearing Procedures

1. The dean or chairman shall convene by written directive the Grievance Committee set up by faculty action on January 10, 1969 (see Appendix B of Faculty Legislation).

2. The dean or chairman shall, in writing, notify the graduate student of the convening of the hearing committee and shall provide the chairman of the hearing committee with a concise written summary of the charges of violation based upon the findings of the inquiry.

3. Upon convening of the hearing committee and receipt of the written charges, the chairman of the hearing committee shall forthwith set a time and place for the hearing by written notification to the graduate student and shall make the necessary arrangements for conducting the hearing. Unless manifestly impossible for reasons of specific unfairness to the graduate student or gross inconvenience to members of the hearing committee or to necessary witnesses, the hearing shall be set to commence not later than five (5) days after receipt by the graduate student of the written notice of the convening of the hearing committee. Failure on the part of the graduate student to attend the hearing without adequate cause shall result in automatic permanent suspension without pay.

4. The hearing shall be conducted on the written charges to determine their truth or falsity. The department chairman or dean who initiated the proceedings has the responsibility for presenting witnesses or documentary evidence to establish the charges. The graduate student shall be accorded the right to counsel of his own choosing, to confront and cross-examine the witnesses against him, and to examine all documents and demonstrative evidence against him. He shall have the right to present testimony of witnesses and other evidence in his own behalf.

5. A complete transcript of the proceedings shall be furnished at the expense of the University.

6. Promptly upon the close of the hearing, the hearing committee shall render its decision, and that decision shall be presented in writing to the graduate student and his department chairman or dean.

III. Disciplinary Action and Appeal Procedure

1. If the decision is adverse to the graduate student, the department chairman or dean who initiated the proceedings shall determine what disciplinary action is to be taken.

2. An appeal may be taken in the manner described in paragraph C of Appendix B to the Faculty Legislation on University Government.